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COMPLETE SPECIFICATION

Improvements in or relating to Washing Apparatus

We, AJEM LABORATORIES INC., a Corporation of the State of Michigan, whose post office address is 38899 Schoolcraft Road, Livonia, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to washing apparatus adapted for industrial applications for cleaning various manufactured articles. This invention is described as embodied in a machine for high-pressure washing, rinsing and drying of metal parts, for example, such as crankshafts and camshafts of internal combustion engines.

The present invention consists in washing apparatus comprising a plurality of substantially uniformly spaced pressure spraying stations located on a supporting frame that also supports an endless conveying element carrying a plurality of jigs at spacings substantially equal to the spacings between the stations and so arranged as to move past said stations, and a sprocket drive for said conveying element, including a ratchet mechanism, arranged to move the conveying element intermittently in steps whereby the jigs move intermittently in steps from station to station, said ratchet mechanism including a stop detent adapted to stop the conveying element with said jigs substantially aligned with the spraying stations.

In many mass-producing type industrial applications involving the fabrication of complicated machined parts and assemblies, it is necessary at one or more points in the production schedule to remove the various soils which adhere to the surfaces of the articles and accumulate as a result of the previous manufacturing and fabrication steps.

The apparatus described herein is particularly well suited for the cleaning of crankshafts, camshafts and the like, and of many other types of parts having bearing surfaces or other complex surfaces of cavities which must be thoroughly cleaned. It is important

that bearing surfaces and all other portions of the parts be thoroughly cleaned of all soils to prevent damage when the parts are assembled and run. The thorough cleaning of close tolerance parts enables their dimensions to be tested with precision. In many cases, the presence of soils on these precision parts cause erroneous readings of their dimensions, resulting in the rejection of parts which do not actually lie outside of the permissible tolerance range, or vice versa.

In order that the present invention may be more clearly understood, reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 is a side elevational view, partially diagrammatic, showing a machine embodying the apparatus of the present invention for washing automobile engine crankshafts and camshafts, the rear side of the machine is omitted to show the arrangement of the various parts;

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1 looking to the right and showing, on enlarged scale, the arrangement of the high-pressure spray nozzles in one of the washing stations of the machine in Figure 1 with a crankshaft in indexed position in this washing station;

Figure 3 is a top view, taken along the line 3—3 of Figure 1, showing a short section of the conveyor used in the machine and showing portions of the chain drive sprocket wheels at the right end of the machine;

Figure 3A is a sectional view taken in the region 3a of Figure 3 looking into the plane of the drawing, showing the way that the cross member 22 is removably secured to the chain;

Figure 4 is a side view, particularly in section, taken along the line 4—4 of Figure 3 looking to the right and showing one of the jigs for holding one end of a crankshaft;

Figure 5 is a side view, partially in section, taken along the line 5—5 of Figure 3 looking to the right and showing the jig for holding the other end of the crankshaft;

Figure 6 is a side view of the indexing

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mechanism used to advance the conveyor chain, this view being taken along the line 6—6 looking to the left in Figure 3; and

Figure 7 is an enlarged side view of one of the adjustable high-pressure spray nozzles used in the washing and rinsing stations of the machine in Figure 1.

In the machine shown in Figure 1, the crankshafts 12 to be cleaned are transferred in sequence from a production line at the left of the machine (not shown) onto pairs of holding jigs 14 which are arranged near opposite sides of a continuous conveying element 16 so as to support the crankshafts horizontally and extending across the conveying element from side to side, as seen in Figure 2. This conveying element 16 comprises a pair of spaced parallel chains 18, as seen in Figure 3, with a plurality of removable frames 20 extending between the chains at every fourth link, each frame including a cross bar 22 with one of the holding jigs 14 on the top side near each end, as described in detail below.

The conveying element 16 passes up around a pair of large idler sprockets 24 at the left of the machine which engage the chains 18 and guide the element into the machine where it is pulled to the right by means of a pair of drive sprockets 26. The conveying element 16 passes in succession through a washing stage 28, a rinsing stage 30, and a drying stage 32 and then exits from the machine near the drive sprockets 26, the cleaned crankshafts then being removed from the jigs 14 and passed in sequence to the next production step. The empty conveying element 16 returns under the machine past a number of smaller idler sprockets 33 with the chains 18 running along supporting guide tracks 34 formed by angle irons extending longitudinally of the machine underneath it.

In each stage are a number of separate stations 35 wherein particular areas of the crankshafts are subjected to high speed streams of fluid. The element 16 is advanced intermittently through the machine with each pair of jigs 14 pausing briefly in each station in succession. A partition 36 with a small door 37 for the conveyor and crankshaft separates the stages 28 and 30, and a similar partition 38 with a door 39 separates the stages 30 and 32.

At the bottom and extending off to one side (see also Figure 2) of the washing stage 28 is a tank 38 holding washing liquid, indicated at 40. This solution is sucked into the bottom of a two-stage centrifugal pump 41 and forced out of the upper stage 42 at extremely high pressure through pipes 43 and a pair of manifolds 44 extending along parallel to the chains 18. Connected to the manifolds 44 are a plurality of transverse pipes 46, some extending across the machine above the conveying element 16 and others below. Each of these transverse pipes 46 includes

several openings over each of which are clamped adjustable spray nozzles 48 and jet nozzles 50 described in detail hereinafter. These nozzles 48 and 50 are arranged to direct a high speed spray or stream, respectively, of washing solution at various predetermined areas of each crankshaft, as they pause in each station. The pump 41 is supported by a bracket 52 from the top 53 of the side extension of the tank. The pump has a vertical shaft 54 extending up in a housing 56 through a bearing 58 to sheaves 60 driven by V-belts from a suitable electric motor 62. A suitable high pressure two-stage centrifugal pump for use in the machine is described in detail in the copending application No. 29205/1955 (Serial No. 804,997).

As indicated in Figures 1 and 2, the adjustable nozzles 48 are aimed at various specific areas of the crankshaft. A pair of these nozzles 64 and 66 are aimed at opposite ends of the crankshaft to squirt streams of washing solution into the passages in the interior of the crankshaft, to thoroughly clean it. Thus, advantageously, every facet of the crankshaft receives in turn a thorough high pressure washing with the washing solution in each case impinging on the various crankshaft surfaces at the optimum cleaning angles, enabling the cleansing to be done in a brief time.

The partition 36 keeps the washing solution from entering the rinse stage, and, if desired, a flexible curtain may be hung in the door 37 to provide further isolation. As shown in Figure 1, the rinse stage may be substantially identical with the washing stage and parts in the rinse stage performing corresponding functions are indicated with corresponding reference numerals followed by the suffix "a".

After leaving the rinse stage 30 the jigs 14 pass through the drying stage 32 wherein the crankshafts 12 are dried by air drawn in through a steam-heated radiator 64 and driven by a pump 66 into a manifold 68 connected to various hot air nozzles 69. A pair of these hot air nozzles 70 are directed at the opposite ends of the crankshaft in the last station 35 to dry out their internal passages. The connection to the steam pipes in the radiator 64 is made by pipes 72.

As shown in Figure 3, the spaced chains 18 of the conveyor include links 73 and cross pins 74 surrounded by rollers 76. (see also Figure 3A). The inner ends of the cross pins 74 are headed, and their outer ends are held by cotter pins 78. The drive sprocket 26 has teeth adapted to engage every other space in the chains 18.

The frames 20 are removably secured between every fourth link of the chains 18. As shown in Figure 3A, each end of the cross members 22 has a bracket 82 extending at right angles to the member 22 and resting against one of the links 73, and being some-

what wider and longer than the link. A pair of indentations 84 are formed on the outer face of each bracket 82 spaced a distance apart corresponding to the spacing of the heads of two adjacent cross pins 74. Intermediate these indentations 84 is a hole 86 arranged to fit a bolt 88 which extends across through holes in the centers of the two adjacent links 73 and clamps the bracket against the inner link 73. A sleeve surrounds the bolt 88 between the links 73. Thus, advantageously, the frames 20 are enabled to be slid into place between the two chains and clamped in place by only two bolts, being oriented by engagement of the heads of the cross pins 74 with the indentations 84 in the brackets.

Shown in Figures 3 and 6 is the indexing mechanism 90 to index the conveying element 16 through the machine. This indexing mechanism includes a ratchet wheel 92 rigidly secured to a rotatable shaft 94 which turns the drive sprockets 26. The ratchet wheel 92 has four equally spaced teeth 96, each with a radial face 98 facing clockwise as seen in Figure 6.

In order to turn the ratchet wheel 92, a drive arm 100 is swingably mounted on the shaft 92. The arm 100 comprises a pair of parallel spaced plates, as seen in Figure 3, which straddle the ratchet wheel 92. Engaging the teeth 96 is a pawl 102 having one end pivotally secured between the plates of the drive arm, with its free end biased by a spring 104 thrusting against an abutment 106 on the arm. The drive arm 100 is swung back and forth, as indicated by the arrow 108 in Figure 6, by means of a piston rod 110 pivoted at its free end to the arm 100 and a pneumatic cylinder 112 supported by means of trunions 114 on the frame of the machine.

To advance the conveying element 16, air under high pressure is introduced from a control unit 116 through a flexible hose 118 into the lower portion of the cylinder 112 driving a piston (not shown) within the cylinder up, swinging the arm 100 counterclockwise around the shaft 94, engaging the pawl 102 with a face 98 and turning the ratchet wheel and shaft 94.

In order to enable precise positioning of the jigs 14 at the various stations 35, a stop detent 120 pivotally mounted on a shaft 122 carried by an adjustable bracket 124 is used. The stop detent is arranged to engage radial faces 126 of a stop ratchet wheel 128 to stop the conveying element 16 in the desired positions. The wheel 128 is similar to the wheel 92 and is rigidly secured to the shaft 94, but with its radial faces turned counterclockwise about the shaft 94 to face the free end of the detent 120. The detent bracket 124 is secured by bolts 130 to the machine frame, and is adjusted in position by means of horizontal bolts 132 so as precisely to align the jigs 14 in the stations 35 at the end of each stroke

of the arm 100.

Secured to the machine frame near the terminal position of the outer end of the arm 100 is a control switch 134 which is struck by an adjustable stop 136 on the arm 100. The switch 134 is connected to the air control unit 116 and causes the air supply to be shut off from the hose 118 and turned on in a hose 138 connected to the upper end of the cylinder 112 to return the arm 100 to its initial position in readiness for the next operation.

Near the initial position of each stroke of the drive arm 100 is another control switch 135 which is actuated by the adjustable stop 136 as the arm 100 returns to its initial position. This switch 135 is connected to the air control unit 116 and causes the air supply to be shut off from the hose 138 and again turned on in the hose 118 so as to imitate the next indexing operation. The period of time during which the articles remain in the respective stations within the machine is determined by the time which elapses between the actuation of the switch 134 and the commencement of the next forward stroke of the arm 100. This dwell period can be controlled by controlling the rate of return of the drive arm by adjusting the supply of air fed through the hose 138.

In order to lift the detent 120 from engagement with a face 128 prior to the beginning of each indexing operation, a shoulder 140 is provided at one side of the detent 120. This shoulder is engaged by a cam arm surface 142 near the inner end of one of the plates of the arm 100. As the free end of the arm 100 swings back in a clockwise direction, the cam 142 rises up under the shoulder 140 and lifts the detent 120 out of engagement with the stop ratchet wheel.

During the next stroke when the arm 100 again moves clockwise, the cam 142 drops down and allows the detent 120 to drop down into engagement with the stop ratchet wheel.

As shown in Figure 2, as the chains 18 pass through the machine they are supported by tracks 143 formed by angle irons extending longitudinally through the machine. The ends of these tracks 143 extend out near the large sprockets 24 and 26 at each end.

In case there is an inadvertent delay in unloading the crankshaft 12 at the discharge end of the machine, a lever 144, with its free end inclined and in position to be depressed by the end of a crankshaft, is connected to a switch 146. The switch 146 is connected electrically by a cable 147 to the air control unit 116 and shuts off the air supply from the hose 118, stopping any further indexing until the crankshaft on the lever 144 is unloaded.

Any fumes in the chambers 28 and 30 are removed through ducts 148 by an exhaust fan 149 above the machine.

In Figure 7 is shown, on considerably enlarged scale, a cross-sectional view of one of the adjustable spray nozzles 48 clamped in

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position on a pipe 46, shown in cross section. A large hole 150 is drilled in the pipe 46 and arranged to face in the general direction toward which the spray or stream of high speed fluid is intended to go. This nozzle is described and claimed in our copending Application No. 21393/1957 (Serial No. 817,860) which is divided from the present application.

The adjustable nozzle includes a generally C-shaped clamp having one end 152 with a surface broad enough to cover the hole 150. A smaller orifice 154 extends through the end 152 of the clamp and is over the larger hole 150 in the pipe 46. The opposite end 155 of the C-shaped clamp has an adjustable clamping bolt 156. The stream of fluid issuing from the small orifice 154 passes a bullet-shaped director 158 supported by arms 160 from the end 152 and advantageously is broken into a high-speed spray.

The adjustable nozzles 50 are generally similar to the adjustable nozzles 48 except that in place of the orifice 154 and the director 158, a small pipe (as shown in Figure 2) is secured to the arm 152. The inside diameter of this pipe is smaller than the diameter of the hole 150 in the pipe 46 to enable the angular adjustment of the nozzles 50 over a considerable angular range.

As shown in Figures 4 and 5 the crankshaft supporting jigs 14 on the cross members 22 are generally U-shaped in outline, having arms 161 and 162. The arms 161 and 162 have inner surfaces 163 and 164, respectively, which define a J-shape, the surface 163 is straight and the surface 164 is arcuate so as to support the crankshafts 12 without engaging any of their machined bearing surfaces, thus, advantageously leaving them all completely exposed for efficient thorough cleaning.

The straight surface portion 163 engages a crank arm 166 of the crankshaft off to one side of its associated connecting rod bearing surface. Into the arcuate surface 164 nests one of the counterweights 168 of the crankshaft. As shown, the pair of jigs on each cross member 22 are in reversed position with respect to each other, for they are preferably spaced apart far enough on the cross members 22, as seen in Figure 2, so as to engage the two counterweights and the outer sides of the two crank arms at opposite ends of the crankshafts 12. In order to prevent the crankshafts from sliding crosswise in the jigs 14, U-shaped brackets 170 are secured to at least one of the arms 162 of each pair of jigs. The ends 172 of the bracket 170 point in toward the space above the jig arms 161 and 162 and embrace opposite sides of one of the end counterweights on each crankshaft.

It will be understood that liquid level controls may be used in the tanks and that steam or electric units may be used for heating the wash and rinse liquids. Also, sludge removal apparatus and access openings (not shown)

into the tanks are provided to enable their cleaning.

The positioned washing, rinsing, and drying which is obtained by the method and apparatus described is highly advantageous for any interference between the various liquid streams is avoided so that each stream at each station acts at maximum efficiency in cleaning and drying the assigned area of the article being cleaned.

From the foregoing description it will be understood that the washing apparatus of the present invention are well adapted to provide the many advantages discussed above, and that they can be adapted to a wide variety of industrial washing and cleansing operations and that various changes or modifications may be made therein, each as may be best-suited to a particular application, and that the scope of the present invention, as defined by the following claims, is intended to include such modifications or adaptations limited only by the prior art.

WHAT WE CLAIM IS:—

1. Washing apparatus comprising a plurality of substantially uniformly spaced pressure spraying stations located on a supporting frame that also supports an endless conveying element carrying a plurality of jigs at spacings substantially equal to the spacings between the stations and so arranged as to move past said stations, and a sprocket drive for said conveying element, including a ratchet mechanism, arranged to move the conveying element intermittently in steps, whereby the jigs move intermittently in steps from station to station, said ratchet mechanism including a stop detent adapted to stop the conveying element with said jigs substantially aligned with the spraying stations.

2. Apparatus as claimed in Claim 1 in which the conveying element comprises one or more endless chains each of which is engaged by a sprocket wheel to which a rotatable shaft is secured that has a ratchet wheel connected thereto, and comprising further an arm rotatably mounted on said shaft, a pawl pivotally mounted on said arm and biased to engage said ratchet wheel, a cylinder, a piston reciprocally mounted in said cylinder, and mechanical coupling means between said piston and said arm for moving said conveying element, and in which the stop detent is associated with the ratchet wheel, said piston and detent being arranged intermittently to stop said conveying element with said jigs at successive ones of said washing stations.

3. Apparatus as claimed in claim 2, in which a second ratchet wheel is connected to said shaft and faces in the opposite direction from said first ratchet wheel, the stop detent being biased to engage said second ratchet wheel to stop said conveying element with said jigs aligned with successive ones of said stations, and in which a cam on said arm is

arranged to disengage said stop detent from said second ratchet wheel as said arm returns to its initial position.

- 5 4. Apparatus as claimed in any one of the preceding claims, in which the conveying element comprises a pair of parallel endless uniformly spaced chains supported to move past the stations, and in which a plurality of uniformly spaced frames extends between said chains, the spacing between said frames equaling the spacing between said stations, at least one jig being mounted on each of said frames for supporting articles to be washed.

- 15 5. Apparatus as claimed in claim 4, in which there are a pair of jigs on each frame near opposite ends of the frame, said jigs having a generally U-shape and being arranged concave upwards when the chains pass said stations.

- 20 6. Apparatus as claimed in claim 5, in which at least one of the jigs in each pair has a U-shaped bracket secured on one of its arms, with the ends of said bracket directed toward the space within and above the jig to which it is secured.

- 25 7. Apparatus as claimed in claim 4, 5 or 6, in which each of said frames comprises a cross member extending between and perpendicular to said chains, in which a pair of parallel brackets extends perpendicularly from opposite ends of said cross member with the outer face of each bracket adjacent a link of one of said chains, each of said brackets having a hole therethrough perpendicular to its outer face, and in which a removable fastening extends through said hole and the adjacent link.

- 35 8. Apparatus as claimed in claim 7, in which the links in said chains are secured together by cross pins, the outer faces of each bracket

40 having a pair of indentations on opposite sides of its hole and spaced apart a distance corresponding to the spacing of the cross pins in said chains for engaging the ends of the respective cross pins for the adjacent link, with said removable fastening engaging said adjacent link between its respective cross pins.

- 45 9. Apparatus as claimed in claim 4, 5 or 6, and adapted for washing crankshafts, in which each station includes a plurality of nozzles connected to sources of fluid under pressure, a pair of J-shaped jigs being located near opposite ends of each spaced frame, the jigs in each pair being spaced a distance approximately equal to the spacing between two crank arms of a crankshaft to be washed, each jig having a projecting arm for contacting a crank arm on a crank shaft and a curved arm for supporting the outer surface of the associated counterweight, the corresponding arms of the jigs in a pair extending in opposite directions and in which a pair of locating stops is provided at opposite sides of at least one jig in each pair.

- 50 10. Apparatus as claimed in claim 9, and comprising further a washing stage, a rinsing stage, and a drying stage, each stage including a plurality of stations, the nozzles in the washing and rinsing stages being connected to sources of high pressure liquid and the nozzles in the drying stage being connected to a source of hot air under pressure.

- 55 11. Washing apparatus substantially as hereinbefore described with reference to the accompanying drawings.

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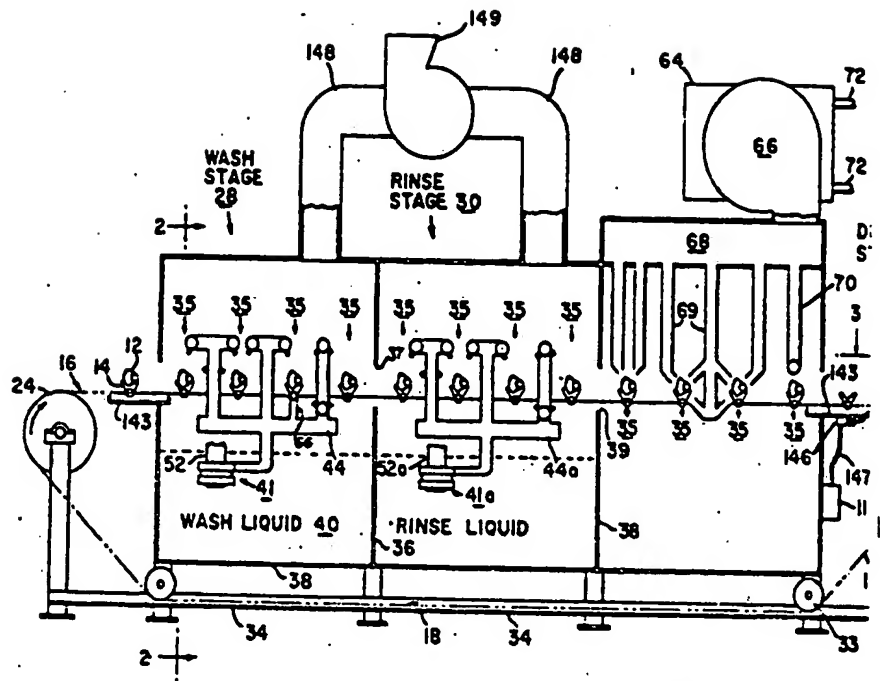


Fig. 1.

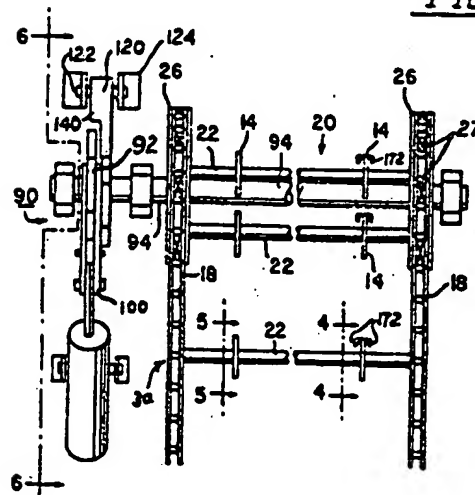


Fig. 3.

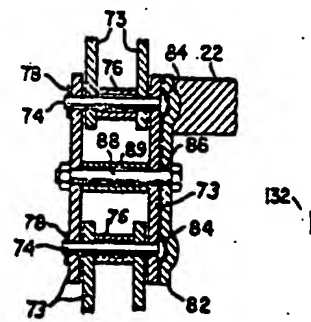


Fig. 3a.

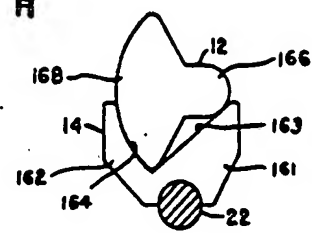


Fig. 5.

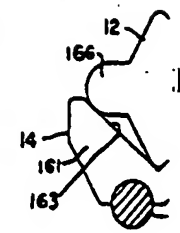


Fig. 4.

Fig. 2.

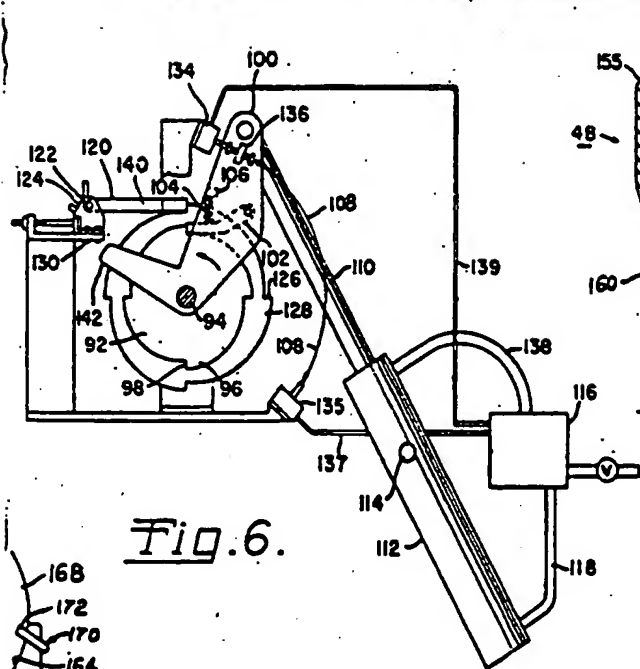
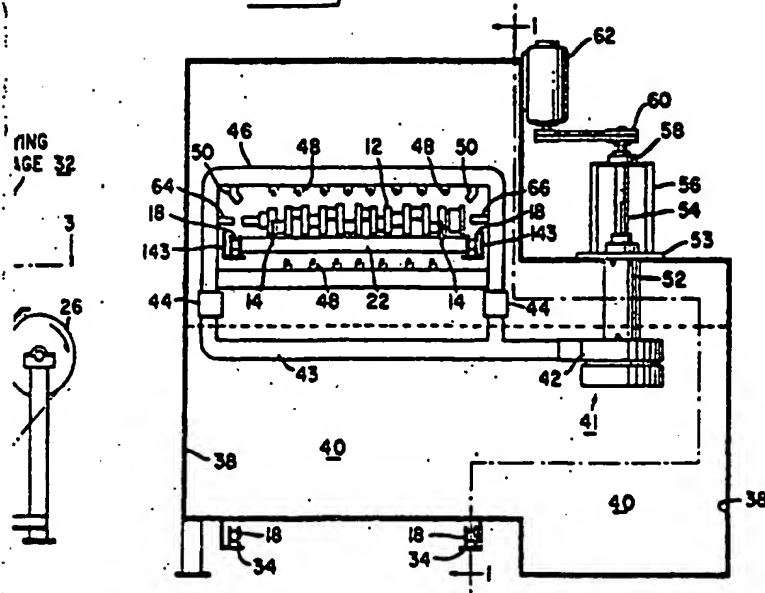


Fig. 6.

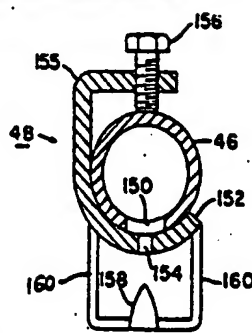


Fig. 7.